Ohio Agricultural Experiment Station.

BULLETIN 87

WOOSTER, OHIO, NOVEMBER, 1897.

THE PERIODICAL CICADA,

(*Cicada Septendecim.*)

OR SO-CALLED SEVENTEEN-YEAR LOCUST, IN OHIO.

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The Bulletins of this Station are issued at irregular intervals. They are paged consecutively, and an index is included with the Annual Report, which constitutes the final number of each yearly volume.

PLATE I.

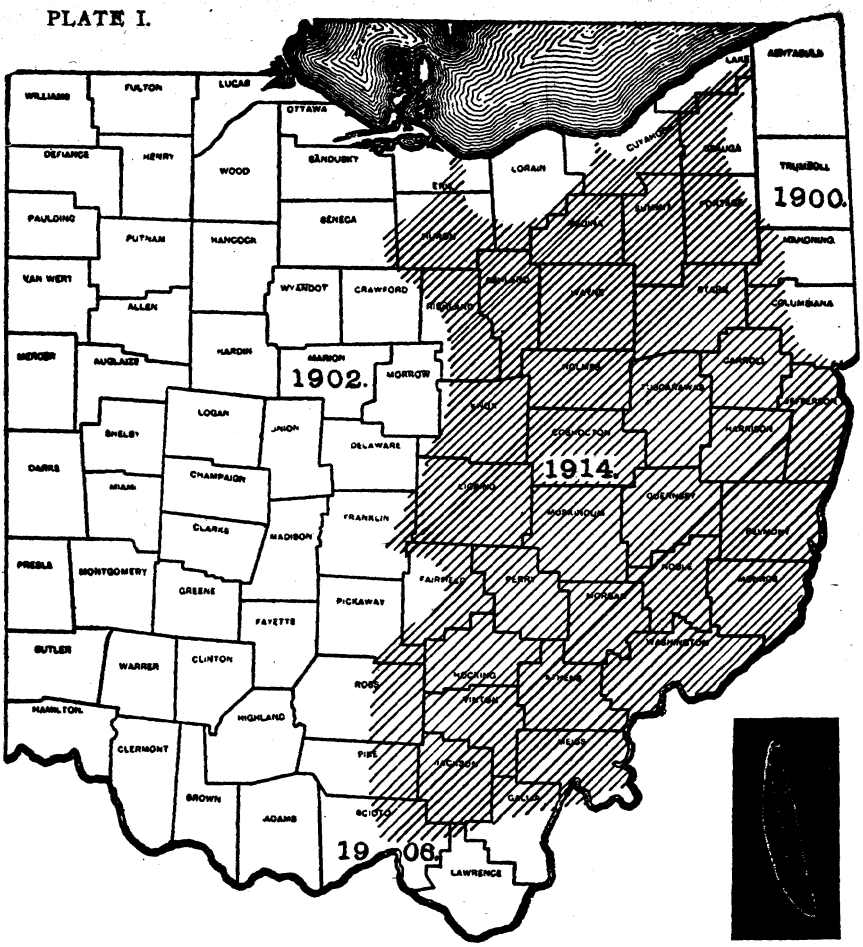

FIG. 1.

FIG. 2.

FIG. 3.

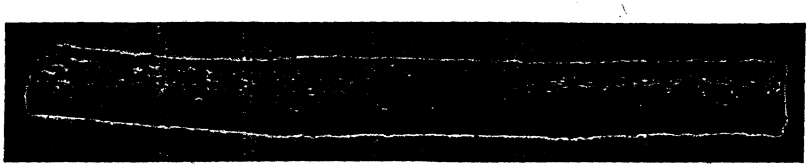

FIG. 4.

FIG. 1. Map showing area over which Brood XV, Periodical Cicada, occurred in Ohio in 1897, and indicating years when the insect will again appear. FIG. 2. Egg of Cicada, much enlarged. FIG. 3. Usual appearance of punctured twig. FIG. 4. Unusual appearance of affected twig. Original.

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BULLETIN

OF THE

Ohio Agricultural Experiment Station.

NUMBER 87. NOVEMBER, 1897.

THE PERIODICAL CICADA, CICADA SEPTENDECIM, OR SO-CALLED SEVENTEEN YEAR LOCUST, IN OHIO.

BY F. M. WEBSTER.

The Cicada is a very ancient insect and has been found in Prussian Amber, and fossil at Copal, Aix, France, in Baden and at Padoboj, Austria.

In olden times, among the Greeks and Egyptians, the Cicada was the emblem of music, and according to Polybius, its effigy was struck on the coins of races who claimed superiority in this art, notably, the Messenians in Arcadia, and the Locrians in Italy. According to Greek fabulous traditions, Aurora, the goddess of early light, had asked eternal life for her husband, Tithonus, the son of Laomedom, whom she had robbed on account of his beauty, but had forgotten to ask for him perpetual youth, and he became old and decrepit, and was rocked in a cradle like an infant, but wearying of life and immortality, in such a form, he begged the power to die.

Aurora said this was not possible, but, preserving her magic, she transformed him into a Cicada, which molts when it is old, and grows young again. In the days of Strabo there stood at Locris a statue to Eunomus, with a Cicada sitting on his cithara. And the legend went that two musicians, Ariston the Locrian and Eunomus of Regium, were contending in song. Ariston claimed for the Sun God his seat at Delphi; but this Eunomus maintained did not suit the dwellers at Regium; and as he warmed to his argument the very Cicada on the bough ceased to sing. Ariston, however, was by no means pleased at this, and still hoped for victory. At this moment a chord in the lyre of Eunomus snapped. The free-born Cicada was not to be beaten in his argument, and, flying to the spot, supplied the native sound of the string.

It was Meleager of Gadara, whose Syria-Greek poems contained among them, the following : —

"O, shrill-voiced insect; that with dewdrops sweet,
Inebriate, dost in the desert woodlands sing;
Perched in the spray-top with indented feet,
Thy dusky body's echoings harp-like ring.
Come, dear Cicada, chirp to all the grove,
The Nymphs and Pan, a new responsive strain;
That I. in the noontide sleep, may steal from love,
Reclined beneath the dark o'erspreading plane."

The word "Cicada" has been derived from *ciccum*, a thin skin, and also from *cito*, quickly, and *cadere*, to fall, a compound of their being short-lived.

The fact that the female Cicada has no note, was also known in ancient times, and old Zenachus used to chide his wife with :

"Happy the Cicadæ live,
Since they have voiceless wives."

It was left to the originator of the Thermometric scale, Réaumur, to carefully study the sounding organs of the male, but as he based his views as to their action, upon studies of dead and dried specimens, his theories have not all been confirmed.

When Dr. Bennett was investigating insects in the Antipodes, the natives used to inform him of the females in this way :

"Old woman galang, galang; no got; no make a noise."

I well remember the first morning I spent in Sydney, New South Wales, when, on visiting the Botanic Gardens, one of the first notes that greeted my ears, was that of a Cicada, stationed upon a low shrub. It was the first time that I had ever heard a Cicada in January, while the poor Cicada sang his last song as he dropped suddenly into my collecting box.

In regard to these musical organs, which the male alone possess, Dr. Harris, in his *Insects Injurious to Vegetation*, pp. 204-205, has written as follows :

"The musical instruments of the male consist of a pair of kettle drums, one on each side of the body, and these, in the seventeen-year Cicada (or locust as it is generally but improperly called in America), are plainly to be seen just behind the wings. These drums are formed of convex pieces of parchment, gathered into numerous fine plaits, and, in the species above named, are lodged in cavities on the sides of the body behind the thorax. They are not played upon with sticks, but by muscles or cords fastened to the inside of the drums.

"When these muscles contract or relax, which they do with great rapidity, the drum-heads are alternately tightened and loosened, recovering their natural convexity by their own elasticity. The effect of this rapid alternate tension and relaxation is the production of a rattling sound, like that caused by a succession of quick

pressures upon a slightly convex and elastic piece of tin plate. Certain cavities within the body of the insect, which may be seen upon raising two large valves beneath the belly and which are separated from each other by thin partitions having the transparency and brilliancy of mica, or of thin and highly polished glass, tend to increase the vibration of the sounds, and add to their intensity."

Just why our periodical Cicada should require so long a time to develop, and, why the adult should appear in different places in the United States, during fourteen out of the cycle of seventeen years, it is impossible to say. My own suspicion, in reference to this phenomenon, is that a glacial period may have had its influence in retarding the development of the species for different periods of time, in different localities. This, however, is to be taken only as an unsubstantiated possibility; but there certainly must have been some influences, in the past, that have retarded or accelerated the development of these insects, and have not exerted the same influence over the entire area of the distribution of the species.

In Ohio, they occur in different places four years out of these seventeen, so that we have, at least, the former number of broods in the state. Of these, brood XXII, appearing in 1885, occurred throughout the whole western half of the state, and extending as far eastward as the Scioto River, from Delaware county, southward, and northward to Lake Erie in the vicinity of the city of Sandusky. The eastern line of the occurrence of this brood XXII, in Ohio, has never been carefully worked out, but generally speaking, west of the line I have indicated, as extending from Sandusky to near Portsmouth, they may be expected to occur during the year 1902.

The next brood to appear in the state will be brood VIII, and it will probably cover the extreme southern portion of Ohio. Most likely this brood will extend northward a little beyond Gallipolis, and westward throughout the counties bordering on the Ohio River to the Indiana line; though Mr. Charles Spintler reported it as occurring at his place three miles west of Waverly, Pike county, in 1889. This brood will appear in 1906.

Brood XIII was reported by Dr. C. V. Riley, in Bulletin No. 8, of the U. S. Department of Agriculture, Division of Entomology, page 30, as having occurred in Champaign county, Central Ohio, in 1861. This report, however, has, up to the present time, not been confirmed, and it is at present doubtful if it ever will be. If, however, it should be again reported it will probable be found to constitute a portion of brood XIII.

On the same authority, brood XIV was reported upon the testimony of Mr. Clark Irvine as having appeared in 1845 and 1862, in Central Ohio, but this statement was not confirmed in either 1879 or 1896, and therefore, it is doubtful if this also is authentic.

Brood XV occurred the present year, 1897, and the area covered by it is indicated by the accompanying map, of which further explanation will be given. See Plate 1.

In 1898 brood XVII is due to occur in Summit county, Ohio, but as there has been no evidence of its appearance since 1864, it is very doubtful, whether this old record can be substantiated. It will be noticed further along that it was reported as occurring at Freedom Station, Portage county, in 1864 or 1865, by Mr. Lyman Jones.

In the year 1900, brood XX may be expected to occur in Ashtabula, Trumbull, Mahoning and Columbiana counties, and in the two last named counties this brood may over-lap brood XV, which occurred the present year, thus, as before stated, giving us four strong, well authenticated broods, during the cycle of seventeen years.

In regard to brood VIII, it is one of the two of which we have record of occurrences covering nearly or quite two centuries.

In Bulletin No. 8, previously mentioned, Dr. Riley has shown that the earliest known record we have at present of the periodical Cicada, is in Morton's Memorial, in which it is stated that it appeared at Plymouth Plymouth county, Mass., in the year 1633. But, as we have no subsequent record in that locality to correspond with the year, and do have abundant record of their appearing one year later, since 1787, it was in all probability a year later, or in 1634, that the occurrence took place. This being the case, we have a record of the occurrence of our extreme southern Ohio brood VIII, for over two hundred and fifty years, as we know they have occurred regularly since 1787. Harris quotes Prof. Potter as recording their appearance at Galliopolis in 1821. (Inj. Ins. p. 210.)

The other brood, of which we have also a very old record, is probably brood XII, which, however does not appear in Ohio. In Stedman's Library of American Literature, volume 1, pages 462, 463, excerpt from the writings of T. M., supposed to have been Thomas Matthews, son of Samuel Matthews, governor of Virginia, we have the following:

"About the year 1675 appeared three prodigies in that country, which, from the attending disasters, were looked upon as ominous presages."

"The one was a large comet every evening for a week or more at southwest, thirty-five degrees high, streaming like a horse-tail westwards until it reached almost the horizon, and setting towards the northwest."

"Another was flights of pigeons, in breadth nigh a quarter of the mid-hemisphere, and of their length was no visible end; whose weights break down the limbs of large trees whereon these rested at nights, of which the fowlers shot abundance and eat them; this sight put the old planters under the more protentous apprehensions, because the like was seen, as they said, in the year 1640, when the Indians committed the last massacre, but not after until that present year, 1675."

"The third strange appearance was swarms of flies about an inch long and big as the top of a man's little finger, rising out of spigot holes in the earth, which eat the new sprouted leaves from the tops of the trees without other harm and in a month left us.

Brood XV, occurring the present year, has probably the next oldest record, although as compared with the two previous statements this is

very modern. It is recorded as far back as the year 1812, by "A. M. B." writing to the Chicago Tribune in 1868. Dr. Harris recorded its appearance in Ohio in 1829, at Muskingum, and 1812 and 1795, at Marietta, (Inj. Ins. p. 210). Mr. J. J. Harrison of Painesville, Ohio, has a distinct recollection of the appearance of this brood, in 1846.

From this time up to the present we have an abundance of testimony as regarding its periodical occurrence. Of brood XX, we have a record of its occurrence in Pennsylvania as far back as 1832 and again in 1849.

Of brood XXII, Dr. Riley, in his bulletin gives a record of its occurrence in the east regularly, every seventeen years since 1715. Mr. Eli Taylor has sent us the following note relative to his experience with this brood in Chester county, Pennsylvania, and with broods XX and XV in Columbiana county, Ohio.

EAST ROCHESTER, OHIO, June 25, 1897.

MR. WEBSTER:

DEAR SIR: The locusts you speak of are up here, and from reports, are doing a very great damage to orchards. The first locusts I ever saw, were in 1817, in Chester county, Pennsylvania. I can just remember carrying them in my apron from the orchard with older boys to feed turkeys. I was some three months over three years old then. They were up again in 1834, while I lived there; in 1837, I came here to live in Columbiana county, and have seen them here either five or six different times; we have a lap here; they come up as often again as in Chester county. Fourteen years ago they were here, and seventeen years ago. They will be here in fourteen years again, and in seventeen years again; the lap is in the neighborhood of Fairfield, in Columbiana county.

Yours with respect,

ELI TAYLOR.

As a further record of the early occurrence of brood XXII, Dr. Riley states that Mr. F. C. Hill of Yellow Springs, Greene county, Ohio, witnessed their appearance in 1834, 1851 and 1868, while a correspondent of the Department of Agriculture from Toledo, Ohio, (July, 1868, Monthly Report) said the appearance that year was their ninth recorded visit in that locality, thus carrying the record of their continued re-appearance every seventeen years since 1732.

In attempting to define the outlines of the area covered by brood XV, in Ohio, we were obliged to rely to a certain extent, upon correspondence, though a considerable portion of the work of determining this outline was done by Mr. Mally and myself personally. One of the first letters received relating to this subject, as well as one of the most interesting, was from Mr. S. C. Larkin, of Rutland, Meigs county, Ohio, which is substantially as follows:

RUTLAND, OHIO, April 15, 1897.

TO EXPERIMENT STATION, WOOSTER, OHIO.

GENTLEMEN: I write to remind you of what, perhaps, you may be already aware that the Cicada, or seventeen-year locust, will again make its appearance in

this part of southern Ohio this year. The first ones appear from the 15th to the 20th of May, according to the warmth or coolness of the spring, and they last about forty-five days, before all are gone. There is another locust district, lying south of ours, whose periods come eight years before ours. The line between the two districts crosses the Ohio river from West Virginia, near the mouth of Old Town Creek in Ohio, hence to Racine, cutting off all of the township of Letart.

From Racine it passes to West Virginia and back again to Ohio at the mouth of Silver Run, just at the upper edge of Gallia county; passing north of Cheshire and through Gallia county, but to what extent I am not informed.

At Letart, where they were expected in profuse numbers in 1889, there were but very few, the reason I presume, was the fact of a hard frost at that place at the time they were coming out of the ground. How long it will take to regain their former number is not known. One thing appears very curious to me; why should the line between the two districts continue straight without any regard to the crooked Ohio river? I think a description and boundary of the locust districts would be agreeable and useful to the inhabitants of this part of Ohio.

Respectfully yours,

S. C. LARKIN.

Starting with this point I endeavored to trace the dividing line between this brood and brood VIII, across southern Ohio. I found Mr. Larkin's statements to be substantially correct as applied to brood XV. This line of separation seemed to cross the Ohio river near Cheshire in Gallia county, Ohio, but in passing down the Columbus, Hocking Valley and Toledo R. R. all indications of their presence disappeared in the vicinity of Evergreen, Gallia county, Ohio, about eight miles northwest of Gallipolis. That this is not far from the dividing line is also indicated by some information given Mr. Alva Agee of Cheshire, Ohio, by the Hon. J. W. McCormick, who stated that they did not occur at Rodney this year, that being in the 1889 territory, but that he found them at Adamsville, a point one mile south of Rio Grande. He had heard but one locust, evidently a stray one, at his place, six miles due west of Gallipolis.

Under date of June 24, 1897, Dr. J. M. Davis, President of Rio Grande College, writes me that the locusts were out in full force at that place, as they were seventeen years ago, thus showing that the dividing line is a short distance, not over a mile, perhaps, south of Rio Grande. Mr. Jas. Q. Shumway, of Scioto, Scioto county, Ohio, writing me under date of May 24, 1897, states that they were very abundant near the place where he lives, which is seven miles north of the Ohio River and one mile south of Harrisonville, Scioto county, Ohio.

I failed to find them about Portsmouth, Ohio, on June 18, 1897, but learned that they occurred in limited numbers some four miles north of the city. Mr. Kinney, of Portsmouth, stated that he had been through the country west of the Scioto River for some eight or ten miles above the city frequently, during the few weeks previous, but had not heard a single note, or observed a single Cicada. I had no trouble in detecting their presence on the east side of the Scioto River, from a few miles above Portsmouth to Waverly, located on the west side of the river,

thirty miles north of the Ohio River. The Scioto River, here, bends broadly to the eastward, but returns to nearly the same longitude at Chillicothe. In riding northwest from Waverly, I found the locusts very abundant for about five miles, when they suddenly ceased to occur, and I found that the dividing line was a little east of Denver, a small station on the Ohio Southern Ry. Mr. Gerard Fowke, of Chillicothe, writing me under date of June 26, 1897, stated:

"I have not heard a Cicada north of Paint Creek, on the west side of the Scioto; as soon as we cross the bridge on the Waverly pike, a mile south of town, we are in the thick of the fray, and the din is incessant. There seem to be millions of them. On the east side of the Scioto, they are abundant on the north slope of Mt. Logan, and to the southward from there. But I cannot say how they are east of that point, as I have not been in the hills beyond Mt. Logan. I went out on the Cincinnati pike yesterday, as far as Copperas Mountain, four miles this side of Bainbridge, and was in the first range of hills south of the creek there, (Paint reaches its southern limit at this point), but did not hear a Cicada at any time in the day."

And again on August 23, 1897, Mr. Fowke writes us:

"The Cicadas have invaded the city (here) and extended just beyond it to the north; but I have not heard one as far as two miles north of Paint Creek, west of the Scioto River. I was at Rock House in Hocking Co. last week, but did not hear their gentle song; but it was not good weather for them to play the band. Mt. Logan is three miles northeast of Chillicothe; it is about five miles to the north end of the hills from town, in a northeast direction; I have heard a few that far out."

Northeast of Chillicothe, I have further information from Mr. Zed. Shaeffer, writing from Drinkle, Fairfield county, dated July 12, saying:

"The locusts have made their appearance here, in this vicinity, but have not done any damage to orchards; but they have damaged the timber. Orchards further east of here have been damaged a great deal. They were not so bad on young trees, nor were they as plentiful as they were seventeen years ago, and also thirty-four years ago. They have all disappeared by this time."

Mr. Jacob Defebaugh, writing from Laurelville, in the extreme western part of Hocking county, and a few miles directly south of Drinkle, states that they occurred in his locality in 1829, 1846, 1863, 1880 and the present year, and also that there is a stretch of country between his locality and the Scioto River to the westward, about five miles in width, where the species occurs each time five years later.

Up to July, according to Mr. Ballhoser, they had not arrived at Amanda, Fairfield county, a few miles north of Drinkle. But he did report them as occurring in that vicinity in 1880 and 1882.

These, of course, belong to brood XXII. Mr. D. also states that west of the Scioto River, locusts appear one year later, and they therefore would be due in 1898. This is possibly a mistake, for, if the infor-

mation were correct, they would belong to brood XVII, the unconfirmed one, reported as occurring in Summit and Portage counties, in 1864, though as this is somewhat scattered over North Carolina, West Virginia, New York, Pennsylvania and Wisconsin, there is a possibility that there may be a small area of the occurrence of this brood, which has heretofore been overlooked. A very interesting letter from Mr. Silas Courtright, of near Lancaster, Fairfield Co., dated June 28, 1897, gives us considerable light upon the dividing line of the two broods, which, as it would appear, occurred in his immediate neighborhood:

"Your note of the 21st is at hand. I am located five miles west of Lancaster, and this is not the year for the seventeen-year locust in this vicinity. Am told that they are very plentiful to the east of Lancaster, but none to be found in the west part. The first appearance of the locust in my recollection, was in the spring of 1868. I set out an apple orchard in that year; the trees were very badly stung, but soon recovered and left no marks of injury. Their next appearance was in 1885 and I also set about 250 apple trees out that season, and, as before, the trees were badly stung, but soon recovered and no marks were left of their work. Their next appearance in this locality will be in 1902.

The dividing line, during their last visit, was near the Methodist Camp Grounds, which are situated two miles west of Lancaster. This time it appears that Broad street, which runs north and south, in the above town is the dividing line.

Yours truly,

SILAS COURTRIGHT.

By referring to the accompanying map it will be seen that by following this information, the line of separation here makes a broad bend to the northeastward, coming back to the eastern edge of Franklin Co., where only a very few Cicada were observed by Mr. W. F. Barr, of Brice, Franklin Co. Dr. S. W. Albery, of Ovid, Franklin Co., reports their non-appearance in his vicinity, up to June 30th, but Dr. D. S. Kellicott, of the Ohio State University, tells me that he knows them to have occurred in very limited numbers about six miles east of Columbus. This fully illustrates the uneven occurrence of this brood, especially along the borders of its habitat, a phenomenon which renders the exact determination of this dividing line a matter of extreme difficulty. As will be seen, the data here given are somewhat conflicting and do not exactly correspond with the map, for as the area of habitat is contracted there are almost sure to be small, local spots, or islands of occurrence, so to speak, left behind. From this point northward to Lake Erie, the line of separation between this and brood XXII was carefully worked out by Mr. Mally in person.

Dr. C. D. Van Houten, of Sunbury, Delaware county, collected specimens two miles west of Johnstown, in the western part of Licking county, where they were quite abundant. From Delaware eastward no specimens were found until about five miles east of Centerburg, Knox county.

At Mt. Gilead, Morrow county, no specimens could be found, nor any to the eastward until within five miles of Bellville, Richland county, where they were found to be very abundant in the belts of timber, along streams. At Mansfield they were very abundant, the streets and sidewalks being almost covered with the wings; the locusts evidently having been destroyed by birds.

They were found as far west as Conden, Richland county, about three miles west of Mansfield. A letter since received from Mr. C. Elliott, of Ontario, Richland county, states that they have made a mile's progress westward since the time of the investigation. They were next found one-half mile east of Greenwich, Huron county, but none in the city or immediately west of it. A report stated that they were very abundant at Chicago Junction, Huron county. From Greenwich westward, no locusts were found until reaching Ripleyville, Huron county, five miles west. From there on, across the Huron River, through Chicago Junction to Attica, Seneca county, they were literally swarming, but they were not found further west than the eastern limit of Attica. At Bellevue, Huron county, no locusts could be seen or heard, neither could any information of their occurrence there be obtained. A number of people reported them as being very abundant at Pontiac and Bismarck, southeast of Bellevue. The following letter from Mr. J. W. Close would indicate that this has been their distribution in the cases of previous occurrences:

BELLEVUE, OHIO, May 11, 1897.

F. M. WEBSTER:

DEAR SIR—Yours of the 10th received, and upon inquiring of our farmers here, I find that they agree that this is not the year for the return of the seventeen-year locust, but from my own knowledge of them I know that for the past forty-two years (this is the time I lived here), they have not been numerous enough to do any damage; but from fifteen to twenty miles south-east of here they have been very thick and have done considerable damage, and as near as I can find out this was seventeen years ago.

Yours truly,

J. W. CLOSE.

Going eastward from Bellevue to North Monroeville, Huron county, and then southeast towards Monroeville, locusts were first found, in limited numbers, on Seymour Creek, about one and a half miles south of North Monroeville. Mr. L. W. Saunders of Milan, Erie County, says they are very abundant along the Huron River, three and one-half miles west of Milan, seventeen years ago, but none occurred there this year, even under the very trees where he had seen hundreds of them seventeen years ago. The first locusts found this year were one half mile west of Milan. From Milan northeast through Avery, Erie county, no locusts were found until reaching Mud Creek, which is about one and one-half miles southwest of Huron, Erie County, where a very few were present.

In the city of Huron there were no signs of their presence, neither were they to be found in the woods near the lake shore. In this connection it should be stated that the timber has been very largely cleared, leaving only isolated patches, and in these locusts might possibly have been found west of the line indicated. But in any case they must have been very limited in numbers.

We received the following from Secretary W. W. Miller, of the State Board of Agriculture, Columbus, Ohio:

Replying to your favor of the 24th inst., I have to say that I have no recollection of seventeen-year locusts at or near Castalia, during my residence there, which has been continuous since 1870; and previously I lived there from 1850 to 1861—to the breaking out of the rebellion.

Mr. M. J. Caswell, of Castalia, states that his father never knew of a locust in that vicinity but once, and that was more than seventeen years ago. It seemed to Mr. Caswell that it was twenty or more years ago, as some of his neighbors thought it was about 1867. While another neighbor of Mr. Caswell's recalls the fact that they were bad in Huron county in 1865, and probably this is the date to which Mr. Caswell refers.

Writing from Shinrock, Erie county, four miles south of Huron and about seven miles northeast of Avery, Mr. J. P. Hine states, that the seventeen year locust, up to the 7th of July, had not appeared, either at that place or at Berlin Heights, Erie county, and while they had never been abundant at Shinrock they had formerly occurred at Berlin Heights.

This would indicate that there was but a small area extending so far northward as the lake shore. Mr. W. H. Todd, of Vermillion, Erie county, states that locusts were neither seen or heard in his vicinity.

Mr. E. P. Snyder of Peru, Huron county, reported them abundant at his place and being destroyed by the English sparrows. Mr. W. B. Hall, of Wakeman, Huron county, sends us the following information:

"Your letter of inquiry regarding the seventeen-year Cicada, came promptly to hand. I have diligently listened and searched for even one, and have so far failed to find them. In 1880 I found a very few and saved several for my collection. This year from the appearance, I shall not be able to find even a specimen. I am confident that there were a few last year. I cannot verify my statement by specimens, but I retained their peculiar song in my mind and I heard that same song last year from four or five different individuals. It differs in many ways from the song of the common Cicada. I wished at the time that I could have obtained specimens, but they were too shy."

Mr. E. E. Masterman, of New London, Huron county, reported July 15th, that he found them in the southern part of Bronson, Hartwell, Clarksfield and Brighton townships, but not in the northern part, and even where they occurred they were in irregular and scattered localities. Writing from Brighton, Lorain county, July 14th, Mr. C. E. Fox stated that there were but very few locusts to be found there. Miss

Harriet Mason, in reply to a letter of inquiry from me, in regard to the occurrence of the locusts about Wellington, Lorain county, writes:

"Yes, I have both heard and seen the seventeen-year locust in Wellington this season. They appeared about the middle of June, in large numbers, mostly in the woods and doing apparently no damage. Have not noticed them during the past four or five days, so think they must have ended the days of their generation. People driving between Wellington and Oberlin have not observed them except in the vicinity of Wellington. In Penfield, the adjoining township on the east, they have been as plentiful as here."

While Prof. Lynds Jones, writing from Oberlin, July 2d, states:

"Since your letter came I have been on the lookout for the seventeen-year locusts, and have not found them at all, nor heard of any in this vicinity. I notice, also that grasshoppers are exceedingly rare. Yesterday I had my class out looking for insects. and we found only one grasshopper."

Mr. C. J. Leimbach of Brownhelm, Lorain county, July 17th, writes:

"I have taken the trouble to investigate and I cannot find that the locusts have been in the northern part of this county."

Writing from North Amherst, July 12th, Mr. M. L. Cotton, states, that he has not seen or heard a locust at that place this year. He understood that Pittsfield, Lorain county, was about the border of their territory. Mr. B. B. Adams of Copopa, Lorain county, reported their non-occurrence either there or at Columbia. But there were plenty of them in Strongsville township, lying to the east of Columbia township.

Director C. E. Thorne also found them to be abundant at Strongsville, Cuyahoga county Mr. D. K. Huntington of Coe Ridge, Cuyahoga county, reported that they did not occur in his locality. While Mr. F. E. Carr, writing from Lakewood, Cuyahoga county, July 2d, says:

"The locusts were extremely thick here for a short time, perhaps a week. They made a continuous noise that was almost deafening in places, but they disappeared as quickly as they came and there are none in sight at the present. We have not examined closely but we have not noticed any damage that can be laid to their charge."

Mr. H. Bender, of Parma, Cuyahoga county, writing July 5th, reported much damage being done to young trees in his locality, by reason of the attack of locusts which occurred there in excessive numbers. Mr. Albert V. Taylor, of Cleveland, on the date of June 24th, stated that they had occurred in large numbers near Bedford, while I saw ample evidence, in July of their having occurred at Newburg, Cuyahoga county. But Mr. W. H. Slade reported their non-appearance at East Cleveland and I have myself failed to get any trace of them anywhere along the lake shore east of Cleveland, although, at a distance of two or three miles back from the lake, they were very abundant.

Mr. J. J. Harrison, of Painesville, distinctly remembers that they occurred some three miles nearer the lake shore in 1846 and in 1863 than they did in 1880 or the present year. I was not able to get any trace whatever of the locusts further east than Madison, Lake county, and it is doubtful if those found there were more than stray individuals, as there seemed to be a narrow area, extending northeast from along the zig-zag line between eastern Lake and northeastern Geauga counties. In a note published in the "Geauga Republican," a correspondent says:

"Farmers around Little Mountain at present are wondering to what extent fruit and forest trees will be damaged by the seventeen-year locusts, which have appeared in large numbers in that neighborhood.

"The section visited by these pestiferous insects extends from the south side of the Mountain, along the Carver road, northward through Concord township to Painesville, and as far east as Madison, and is about a mile in width. Their first appearance was noted some two weeks since, and their presence is claimed to be a sure forerunner of a dry season. At present, the attention of the pests seems to be directed to the oak trees on the ridges that skirt the Mountain and on its sides. On Sunday last the noise made by the combined army of pests—a strange whirring sound—the distant murmuring of which sounded like a dire foreboding, or an ill-omen that was to be the sure precursor of plague and pestilence—was plainly audible at a distance of nearly two miles."

Mr. Geo. T. Watts reported none at Geneva, Ashtabula county. In company with Mr. Harrison I drove for a considerable distance southeast of Painesville and found them in excessive abundance to the south of what is locally known as "Johnny-cake Ridge," lying just back of Painesville. But not a locust could be seen or heard either on the summit or along the northern slope of this ridge.

In going southward from Painesville, over the P. & W. Ry., which cuts through what is locally known as "Johnny-cake Ridge," not a note was to be heard, and not a discolored twig was to be seen on tree or shrub; but on leaving the cut, which is by no means a long one, the combined notes of the thousands of Cicadas were clearly heard above the noise of the train, while scarcely a tree or bush escaped the attacks of the females, and some of them would not have been more thoroughly browned if a fire had broken out among them. I had no difficulty in detecting their occurrence along the line of this railroad, as far south as Chardon, Geauga county, and learned that only an occasional one had been heard at Burton, Geauga county. Mr. C. R. Post reported them in some numbers four and a half miles east of Chagrin Falls, Cuyahoga county, but Mr. F. A. Derthick, of Mantua, and Prof. G. H. Colton, of Hiram, Portage county, both report that they did not observe them in that locality. According to Mr. J. V. Wilson, of Hartsgrove, Ashtabula county, no Cicadas were heard in that locality. Mr. L. L. Bogue, of East Orwell, Ashtabula county, made a similar report. Mr. Z. Kibler, of Nelson Ledge, Portage county, report no locusts. And precisely the same reports came from Mr. D. G. Joy, of Southington; Mr. J. H. Mar-

low, of Kenilworth; W. H. Brosius, of Fowler, and C. L. Whitney, of Warren, all of Trumbull county. Mr. Lyman Jones, of Freedom Station, Portage county, gives the following report of them in his locality:

"We are not troubled with the locusts. They only staid with us two days. We have only beech and maple and they are worse on oak timber. They are doing considerable damage in the west part of town in the oak timber, but have not damaged the orchards yet. In 1864 or 1865 (in 1863 perhaps, F. M. W.) they were seen here but did no damage in this part of the county."

Mr. J. H. Ford, of Ravenna, Portage county, stated that there were a few in his vicinity, but I found slight evidence of their occurrence as far east as a point between Cyclone and McClintocksburg on the C. & P. Ry. Mr. E. W. Vickers reported their non-occurrence at Ellsworth Mahoning county, and on a trip from this place to Garrettsville, Portage county, he found a single specimen in Freedom township. Mr. Sherman Hood, of Meander, Trumbull county; Mr. D. W. Stahl, of Tiger, Mahoning connty; Mr. H. K. Woodard, of Lordstown, Trumbull county, all report the non-occurrence of the locust the present year, though Mr. Stahl reports their occurrence in 1881. Mr. Wm. Fullerton, of North Jackson, Mahoning county, reported that he had not seen or heard adult locusts but that he had plowed up some young ones, probably pupæ, in his orchard in the spring of the present year. Mr. H. C. Heasley, of Struthers, while calling at the Experiment Station, stated that there had been no locusts observed up to July 6th, either at Struthers or Canfield, Mahoning county. Mr. North Newton, of Poland, Mahoning county, made a precisely similar report, as did also Mr. E. L. Longenecker, of East Lewistown, Mahoning county. Mr. E. Grant, writing from Alliance, June 30th, stated:

"No locusts here in this immediate vicinity, five miles west and almost the same distance northeast they were very plentiful. I have heard of none as far as four miles south of here."

Mr. H. H. Aultfather reported them in abundance at Minerva, Stark county, but stated that they did not extend east as far as Irondale, on the C. & P. Ry. As will be seen by the statement of Mr. Ely Taylor, of East Rochester, Ohio, which has previously been mentioned, they occurred at that place the present year, and this brood is over-lapped there by brood XX. Mr. J. Jenkins, of Winona, Columbiana county, reported an occasional locust at that place and that six or eight miles south, in the vicinity of Hanover, Kensington, Augusta and East Rochester, they were very abundant. A Mr. Pim, of Augusta, Carroll county, has reported that he counted one hundred and fifty empty pupæ shells within a foot of one of his young apple trees. Mr. W. J. Wight sends us word that there are but few locusts about Salineville, Columbiana county, and that he saw only one specimen.

Mr. W. M. Hill, of East Liverpool, Columbiana county, reported their occurrence at that place in limited numbers. We also have the following information, taken from the diary of Dr. N. B. Hickman, father of J. Fremont Hickman, agriculturist of the Experiment Station, stating that the locusts were very abundant about East Liverpool, June 30, 1883. According to Mr. Alpheus Arter, they did not occur at Lisbon, Columbiana county, and Mr. B. Y. Brown, of Gavers, Columbiana county, gave a similar report from his locality. Hon. A. H. McCoy, of Calcutta, Columbiana county, states:

"No seventeen-year locusts have appeared in this vicinity this year. I have neither seen nor heard any, nor have I found any person who has. My recollection is, and the best information obtained is that locusts in large numbers were here in 1880, and that in 1883 a few were with us. I have made careful inquiries and find that on these dates locusts appeared in this locality."

Mr. Eliphas Cope, of Rogers, Columbiana county, gave us the following record from his locality:

"The seventeen-year locusts were up in 1849, 1866, 1883, and will appear again in 1900, in this section. They were always an innumerable host. They do not appear to eat anything, as they pierced a portion of the young and chiefly horizontal twigs of the present year, many of which may break off. Yet we found no material injury to any tree; it was a modest pruning."

Mr. C. W. McCullough of Steubenville, gives us the following information:

"The seventeen-year locusts have appeared in this vicinity, but not in nearly as great numbers as in former locust years. They have done no injury yet to young orchards as far as I am able to ascertain. In 1846 they were very destructive. They appeared again in 1863, also 1879 or 1880. They seem to be more abundant in the woods than any place else. Where hogs were left kept in orchards and not rung, in late winter and early spring they did an immense amount of rooting. We think now, that they were after the locusts. The English sparrow seems to be destroying many of them. Turkeys and chickens seem to be doing their share in getting them out of the way."

We have the following from Mr. G. E. Scott, of Mt. Pleasant, Jefferson county, dated June 6, 1897:

"The seventeen-year locusts are here, but not nearly so abundant as seventeen years ago, not by one-half, anyhow. They have only been out ten days. They can not do the damage they did seventeen years ago, from lack of numbers, and I am persuaded that they lost vigor by the long continuous cold wet weather. The cold weather seemed to cause them to suddenly disappear. This is the third locust year I have witnessed, and by far the least in numbers of the three. The English sparrows are killing a large number of them, especially about dwellings and in towns."

Mrs. J. B. Ryan of St. Clairsville, Belmont county, July 4, 1897, gives us the following account of them in that locality:

"The locusts appeared in 1846, 1863, 1880 and the present year; they were not bad about the house, but in the orchard they were plentiful. I have not heard them since three weeks ago, when we had a cold spell, with a white frost, which must have killed them, for the noise disappeared and has not returned."

Hon. John Moore, writing from Woodsfield, Monroe county, June 26, stated:

"Locusts prevailed all over the county, but were not numerous, did some slight damage to timber and fruit trees. Locusts nearly all gone; disappeared very suddenly. Have had some very cold nights and very dry weather."

J. H. Devols' Sons, writting from Marietta, Washington county, stated:

"With regard to the seventeen-year locust, will say that it made its appearance here this season. They were not as numerous as in previous visits of 1863 and 1880. There were none at all scarcely around dwellings. They were very plentiful in a small maple grove on our place. We think they were with us about four weeks."

We have thus information giving the outlines of the area covered by this brood of Cicada during the present year in Ohio. There are a few points with reference to some reports from Astabula and Trumbull counties that will be of interest. No locusts occurred at Monroe Center, Ashtabula county, according to H. F. Hitchcock and none at Kinsman, Trumbull county, as reported by Mr. A. W. Leonard, and a similar report came from Gustavus, Trumbull county, given us by Mr. C. G. Williams.

Mr. C. H. Coon of New Lyme, Ashtabula county, said, that there were no locusts in his section; and as he states that they were not more numerous than common seventeen and thirty-four years ago, and that there were a few every year in July and August, I presume he has confused the two species, *Cicada septendecim* and *Cicada tibicem*. Mr. A. Kingsley, of West Andover, Ashtabula county, whose father is a very old gentleman, and has lived for many years in that locality, states that the latter never knew of the occurrence of locusts there. This would indicate that brood XX does not appear in great numbers in extreme north-eastern Ohio.

In the foregoing we have attempted to show, with as much exactness as possible, the area covered by brood XV of the periodical Cicada, and indicated, as clearly as possible, the area that will be covered by the other three broods in the state as well as the years during which they will occur. This has been done chiefly in the interest of orchardists, as it will be advisable not to put out young orchards during the year preceding or the year during which the Cicada is due to appear.

Such planting should either be done a couple of years prior to their

appearance, or else delayed until the year following, unless, of course, it is to be done in the fall, in which case such planting may be done during the fall of the year of appearance.

WHAT IS A CICADA?

In the first place it is not a locust, although it has been termed such since the beginning of history in America. This shows the uncertainty of common names, and certainly affords sufficient grounds for the use of scientific names, which are the same all over the world.

The trouble is, that common names are very loosely applied, especially to insects, and in common parlance pretty nearly everything that creeps or flies is liable to come under the generally applied term "bugs."

The recent and very laudable attempt to introduce nature studies into our public schools, if it does nothing more, will, or at least should bring about a more careful use of the names of common insects. It is not necessary that elementary entomology should be technical, but, unless it is truthful to the best of our present knowledge, it is really likely to result in much confusion and possible harm. A locust, proper, is a grasshopper, and the Egyptian locust of the Bible was a grasshopper, with a very close resemblance to the very one now found nearly or quite all over Ohio, and sometimes it is quite numerous.

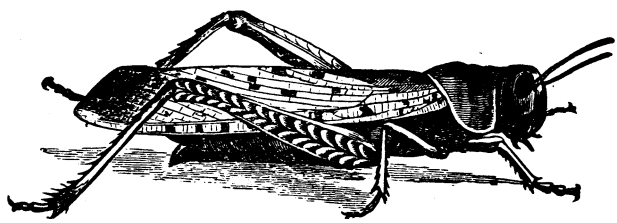


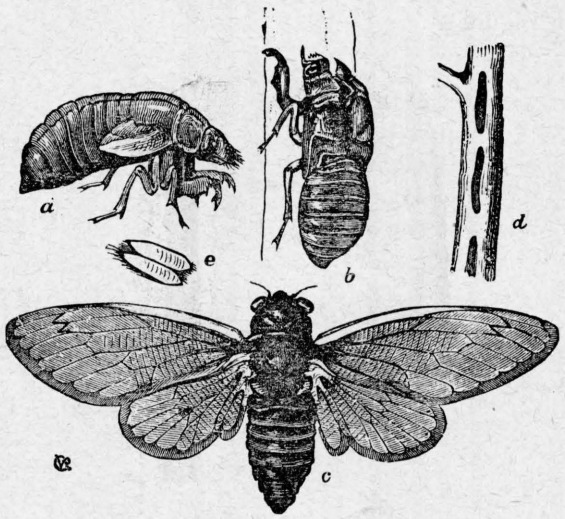
FIG. 1. American Schistocerca, *S. Americana.*

After Riley in Eighth Missouri Rep., page 103. Used by courtesy of U. S Department of Agriculture.

This is almost exactly like the locust of bibical history, as I have the two side by side. The Egyptian species is known to science as, *Schistocerca peregrinum*, and the likeness between the two insects is indicated by the first name, which is applied to both species. *Schistocerca paranensis* is a destructive species in South America. The western grasshopper is simply another kind of locust, much smaller and very closely resembling, in appearance, some of the common grasshoppers of Ohio. True locusts have jaws and consume vegetable matter. The Cicada is really a true bug, distantly related to the squash bug and the chinch bug, and does not have a biting but a sucking mouth, this is shaped somewhat like a bill or beak, and when not in use, is bent back underneath the body and between the bases of the front pair of legs, as is shown in figures 3, 5 and 8.

In figure 3, this beak is shown in a position ready for use. The Cicada then, cannot eat the leaves of trees and can only partake of liquid food. The young, are also provided with this kind of mouth, by which they are enabled to extract the sap from the roots of trees, and it is this way that they subsist.

The true Periodical Cicada is shown in figures 2, 3, 5.



FIG, 2.

Seventeen-year Cicada; *a*, pupa; *b*, cast pupa shell; *c*, imago; *d*, puncture in twig; *e*, two eggs. (After Riley, in First Mo. Rep., page 23.) Used by courtesy of U. S. Department of Agriculture.

Figure 2, illustrates the insect, in the egg, the pupa and adult stages, giving a back view of the adult, while Fgure 3, gives a side view of the same, showing both the mouth and ovipositor.

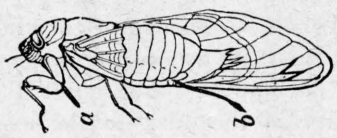


FIG. 3.

Seventeen-year Cicada, side view of female to show beak, *a*, and ovipositor, *b*. (After Riley in First Mo. Rep.) Used by courtesy of U. S. Department of Agriculture.

A Cicada, then, is one of the true bugs, Hemiptera, while a locust is really a grasshopper, one of the Orthoptera.

HOW IT BREEDS.

The Cicada issues from holes made in the ground from below, in the pupa stage, a condition corresponding to the chrysalis of the butterfly. Its appearance at this time is shown at *a*, and *b*, in Figure 2.

Where the land is very flat and the drainage imperfect, these pupæ often construct over these holes in the ground chambers or galleries of clay shown in Figure 4*.

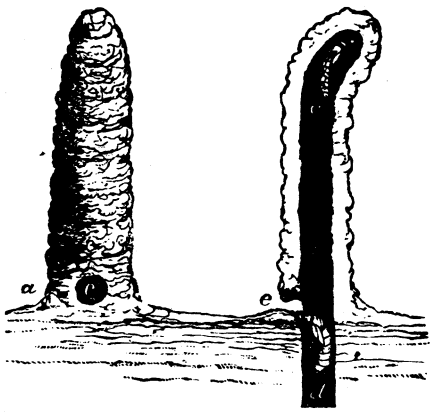


FIG. 4.—Seventeen-year Cicada: Galleries made by pupa; *a*, front view; *e* orifice; *b*, section; *c*, pupa awaiting time of change; *d*, pupa ready to transform. (After Riley in First Mo. Rep.) Used by courtesy of U. S. Dept. Agriculture.

These elevated chambers are about four inches in length, with a diameter on the inside of a little over one-half an inch, with a round hole in the wall at the base, and the top slightly bent to one side.

According to Mr. S. S. Rathvon, of Lancaster, Pa., as quoted by Dr. Riley, the pupæ may often be found in the upper end of these galleries, which are supposed to be constructed as a protection against being drowned, awaiting the proper time to emerge and make their way to trees, upon which they are to transform to adults. For some reason, these pupæ prefer to make their way to the upper world during the cool of the day or perhaps during the night. But I have generally found them, myself, most active in the dusk of the evening. Dr. Riley has found a few stragglers continuing until midnight. They may be noticed in great numbers in town, emerging from the lawns and making their way to trees, often crossing the pavement to do so, and, in fact, even emerging from between the bricks thereof. The forward pair of legs, as

*This has since been questioned by Dr. J. A. Lintner and others, and as yet no definite explanation can be given for the construction of the clay chimneys.

will be seen from *a*, fig. 2, are constructed for digging, and also for climbing, and after they have made their way from the ground to the trunks, branches, and even the leaves of trees and bushes, they fasten themselves by their hooked claws, and in a short space of time, probably about an hour after establishing themselves, the skin splits along the middle of the head and back, and a fully developed insect crawls forth, leaving the empty shell, as shown at *b*, in Figure 2. The following description of the emerging of the fully developed insect is extracted from Riley's report, included in that of the U. S. Commission of Agriculture for 1885, page 238.

"The colors of the forming Cicada are a creamy-white, with the exception of the reddish eyes, the two strongly contrasting black patches on the prothorax, a black dash on each side of the coxæ and sometimes on the front femora, and an orange tinge at the base of wings.

"There are five marked positions or phases in this act of evolving from the pupa-shell, viz., the straight or extended, the hanging, head downward; the clinging, head upward; the flat-winged, and finally the roof-winged. In about three minutes after the shell splits, the forming imago extends from the rent almost on the same plane with the pupa, with all its members straight and still held by their tips within the exuvium. The imago then gradually bends backwards and the members are all loosened and separated. With the tip of the abdomen held within the exuvium, the rest of the body hangs extended at right angles from it, and remains in this position from ten to thirty minutes or more, the wing-pads separating, and the front pair stretching at right angles from the body and obliquely crossing the hind pair; they then gradually swell, and during all this time the legs are becoming firmer and assuming the ultimate positions. Suddenly the imago bends upward with a good deal of effort, and clinging with its legs to the first object reached, whether leaf, twig, or its own shell, withdraws entirely from the exuvium and hangs for the first time with its head up. Now the wings perceptibly swell and expand until they are fully stretched and hang flatly over the back, perfectly transparent, with beautiful white veining. As they dry they assume the roofed position, and during the night the natural colors of the species are gradually assumed.

"The time required in the transformation varies, and, though for the splitting of the skin and the full stretching of the wings in the flat position, the time is usually about twenty minutes, it may be, under precisely similar conditions, five or six times as long. But there are few more beautiful sights than to see the fresh-forming Cicada in all the different positions, clinging and clustering in great numbers to the outside lower leaves and branches of a large tree. In the moonlight such a tree looks for all the world as though it were full of beautiful white blossoms in various stages of expansion."

THE VARIATION IN TIME OF APPEARANCE.

In extreme southern Ohio they will probably put in their appearance about the middle of May, and the first intimation I had of their appearance in Wooster, Wayne county, was on May 28th, when I found a full complement of wings lying upon the pavement under a shade tree. So that there probably would not be more than two weeks difference, from the time of earliest appearance, between southern and northern Ohio.

Dr. Riley has called attention to the fact that Dr. E. S. Hull, of Alton, Illinois, by constructing underground flues for the purpose of forcing vegetables, caused the Cicadas to issue from the ground thus prematurely heated, as early as the 20th of March, and at intervals thereafter until May. It is well known that a few individuals may occur not only the year preceding the one during which they are due, but they may also occur in equally limited numbers during the year following.

Prof. Lester F. Ward reported to the Biological Society of Washington that he had heard the song of the Cicada in October of that year, 1884.

In regard to the length of time during which they occur in perceivable numbers, it is probably not far from four to six weeks. Here at Wooster, there are probably a few present prior to May 28, and they disappeared very suddenly from the Station grounds, between the 21st and 28th of June, though in the woods, they continued to remain for sometime afterwards. As will be noticed from the correspondence given in the preceding pages, this period was fore-shortened in some sections by natural enemies to a very few days, and hence it is questionable if this brood will again make its appearance in these localities.

OVIPOSITION.

After pairing, the females deposit their eggs in the twigs of different trees; and though for this purpose they seem to prefer the oaks and the hickories, they oviposit in almost every kind of deciduous tree, and even in herbaceous plants and in evergreens. I have seen their eggs in the Chestnut, Locust, Willow, and Cottonwood, in peach twigs of not more than one-eighth of an inch in diameter, and also in the stems of the common Eupatorium; while R. H. Warder, of Cincinnati, Ohio, has found them in the following evergreens: *Thuja occidentalis*, *Juniperus virginiana*, and *Abies canadensis*, but was unable to find any trace of their work in either of our common pines—*Pinus austriaca*, *P. strobus*, or *P. sylvestris*. Dr. Harris (Inj. Ins., p. 212) has described the mode of ovipositing as follows:

"They select, for this purpose, branches of a moderate size, which they clasp on both sides with their legs, and then bending down the piercer at an angle of about forty-five degrees, they repeatedly thrust it obliquely into the bark and wood in the direction of the fibres, at the same time putting in motion the lateral saws, and in this way detach little splinters of wood at one end, so as to form a kind of fibrous lid or cover to the perforation. The hole is bored obliquely to the pith, and is gradually enlarged by a repetition of the same operation, till a longitudinal fissure is formed of sufficient extent to receive from ten to twenty eggs. The side pieces of the piercer serve as a groove to convey the eggs into the nest, where they are deposited in pairs, side by side, but separated from each other by a portion of woody fibre, and they are implanted into the limb somewhat obliquely, so that one end points upwards. When two eggs have been thus placed, the insect withdraws the

piercer for a moment, and then inserts it again and drops two more eggs in a line with the first, and repeats the operation till she has filled the fissure from one end to the other, upon which she removes to a little distance, and begins to make another nest to contain two more rows of eggs. She is about fifteen minutes in preparing a single nest and filling it with eggs; but it is not unusual for her to make fifteen or twenty fissures in the same limb, and one observer counted fifty nests, extending along in a line, each containing fifteen or twenty eggs in two rows, and all of them apparently the work of one insect. After one limb is thus sufficiently stocked, the Cicada goes to another, and passes from limb to limb and from tree to tree, till her store, which consists of four or five hundred eggs, is exhausted. At length she becomes so weak, by her incessant labors to provide for a succession of her kind, as to falter and fall in attempting to fly, and soon dies."

To which Dr. Riley adds in Bulletin 8, previously quoted, the following facts.

"The female always saws with her head upwards, i. e., towards the terminal part of the branch, except when she comes in contact with a side shoot, when, instead of shifting a little to one side, she reverses her position, and makes two punctures in an opposite direction to the rest, and thus fills up the straight row close to the base of the side shoot. The eggs [Plate I, Fig. 2.] are of a pearl-white color, one-twelfth of an inch long, and taper to an obtusa point at each end. They are deposited in pairs, but separated by a strip of wood, which is wider—and thus causes the eggs to be further apart—at the bottom of the grooves than at their commencement. The punctured twigs [Pl. I. Fig. 3.], frequently break off and die, though the great majority remain green and recover from their wounds."

As usual, the injury inflicted is slight, except in cases of very young orchards, and I have seen in one case a, to me at least, unique form of attack. This is shown in Plate, I. Fig. 4, and instead of the regular, quite conspicuous punctures, Plate I. Fig. 3, made by the female for a nidus, she appeared to have simply thrust her ovipositor into the wood, and with no further external wound deposited her ova. Riley says further:

"Indeed there is every reason to believe that the eggs seldom hatch in those twigs which break off and become dry, but that the life and moisture of the twig are essential to the life and development of the egg, for the eggs are noticably larger just before hatching than when first deposited, showing that they are, to a certain extent, nourished by endosmosis of the juices of the living wood. Mr. Rathvon has also recorded the fact that the Cicada eggs are always shriveled in twigs that are amputated by the Oak-pruner (*Stenocorus villosus*, Fabr.)

"In the healing of the punctured parts a knot usually forms over each puncture but a portion of an apple twig was sent to me by Mr. John P. McCartney, of Cameron, Clinton county, Mo., and which was punctured in the year 1862; though the wounds had so well healed on the outside, the grooves inside had not filled up, but still contained the minute, glistening egg-shells, from which the young larvæ had escaped six years before."

Dr. E. W. Claypoole, of Akron, tells me that he saw where a Cicada had attempted to oviposit in the leaf stalk of hickory. Eggs from twigs

collected at Wooster, Ohio, July 31st, 1897, hatched August 10th to 25th. From a series of observations made in the field by Mr. Mally, it would appear that where the twigs became detached within a few days after oviposition the eggs did not hatch, thereby strengthening the statements made, that the eggs are to some extent nourished by the juices of the living wood. It does not seem, however, necessary that the twigs should continue to live and grow until the young hatch, though it may be possible that a growing twig might have the effect of widening the cavities, made by the female in oviposition, and thus enable the young to more readily escape. But if this were necessary it would be difficult to explain why females should oviposit after the manner shown in Pl. I., Fig. 4.

There are two distinct forms of this Cicada, one of which, is considerably smaller than the other, and both are shown in Fig. 5.

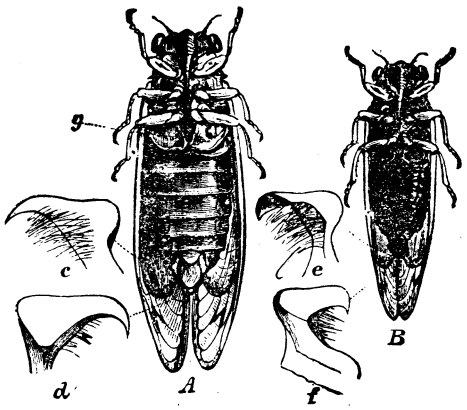


FIG. 5—Seventeen-year Cicada. A, male of typical form; *c*, *d*, genital hooks; *g*, singing apparatus. B, male of the small form (*cassinii*); *e*, *f*, genital hooks. (After Riley and Hagen in Riley's First Mo. Rep.) Used by courtesy of the U. S. Dept. Agriculture.

It was on the larger of these forms that all of our observation about Wooster, were based, and in fact very few of the smaller ones were observed, the single specimen that I found in Wooster, being of the form shown at *B*, in the figure.

THE YOUNG.

When newly hatched, the young are still enveloped in an exceedingly fine membrane, which is usually cast off as they make their way out of the egg, and as our twigs containing the eggs were placed vertically under bell glasses, the top of the table under these bell glasses

was thickly covered with cast membrane. The young itself is of a white color, slightly less than one sixteenth of an inch in length, and the form is shown in Figure 6.

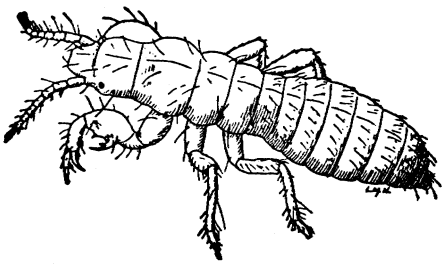


Fig. 6.—Newly hatched young, enlarged. Original.

As soon as the young have extracted themselves from the thin membrane they drop to the ground, and make their way downward. It will be noticed from the figure that the forward feet are particularly well adapted for digging.

Dr. Riley followed the larvæ, or young, for the first six years of its development with considerable care, and the following is quoted from his report as United States Entomlogist, for the year 1885, which is included in the Report of the United States Commissioner of Agriculture, for that year, page 236:

"I have thus been able to follow the larvæ for the first six years with great care, and for subsequent years with less care and continuity. As we might expect from the chronological history of the species, the development of the larvæ is extremely slow, and at six years old it has hardly attained one-fourth its full size. Another interesting result is that, notwithstanding this slow development, molting takes place quite frequently, *i. e.*, the number of larval stages is more than one per annum, and probably twenty-five or thirty in all; whereas in Homoptera generally—the suborder to which the Cicada belongs—it ranges from two to four. In any hypogean insect which continually uses its claws in burrowing, the need of shedding and renewing those organs is apparent, and may afford the chief explanation of this repeated exuviation though the slow development is a factor, since my own experience has shown in the larvæ of other orders, that in proportion as development is slow, exuviation is frequent. The changes with each molt are, in our young Cicada, most noticable in the antennæ and in the front legs and their armature, for the general form undergoes but little change, the body very gradually shortening and thickening, and the color darkening with age."

In regard to the depth to which the larvæ are capable of going, Mr. M. W. Breece, of Delaware, cites an instance where a roadway was graded through the crest of a hill, the excavation extending to a depth of about thirty feet, and it is claimed that the Cicada pupæ made their way up through the surface at the bottom of the excavation. In the spring of 1893, an old orchard was dug up on the Experiment Station

grounds, at Wooster, and from about the roots of these trees a large number of larvæ were taken. These varied in length from less than half an inch to a little over an inch, the latter being as long but more slender than specimens collected from another part of the grounds March 20th, of the present year, by Mr. Mally. In regard to the food of young locusts, I quote again from Dr. Riley as follows:

"A good deal of difference of opinion has been expressed by different writers as to the food of the Cicada larva, and this is not to be wondered at, from the fact that there is great difficulty in observing it feed. Dr. G. B. Smith insisted that it obtained its nourishment from the moisture of the earth through capillary hairs at the tip of the proboscis, while others have seen it with its beak inserted in the roots of trees and pumping the sap therefrom. My own observations indicate that both methods of obtaining nourishment may obtain. The former method I have never witnessed, but it is insisted on by Dr. Smith, from his own observations, and receives support from the well known fact that the Cicada will issue from ground that has been cleared of timber and cultivated for nearly seventeen years, and that other species are known to issue from the prairies.* The truth of the matter seems to be that the Cicada can and does go for long periods without nourishment, where such fasting is necessitated, and that in the earlier years of its development, more particularly, it feeds on the rootlets or radicals, not alone of trees, but of herbaceous plants. In my own observations I have rarely found it more than 2 feet below the surface during the first six or seven years of its life, and almost invariably in an oval cell, and more often away from roots than near them. Yet I have also found it with beak inserted, and it will often hang fast by the beak after being unearthed. That the larva is capable of going to great depths seems to be well attested by observers, and I have recently received a communication where the writer says he found it 20 feet below the surface. It is difficult to say how many of such reports are based on the unobserved tumbling of the larva from higher levels, but where the insects have been observed to issue from the bottoms of cellars 10 feet deep, the information would certainly seem to be reliable. The method of burrowing and making its cells is quite interesting. It scratches away the walls of its cell with the trasal claw just as one would do with a pick, and if it is rising so that the earth removed naturally falls to the posterior end of the burrow, it simply presses the detached portions on all sides, and especially on the end of the cavity, by means of its abdomen and middle and hind legs. If, however, it is burrowing downward and the loose soil has to be pressed against the tip of the cavity, it uses its broad front femora very dexterously in making a little pellet of the soil and in placing it on the clypeal or front part of the head, when the load is carried up and pressed against the top of the cavity.

"The motions made in cleaning its forearms remind one very forcibly of those made by a cat in cleaning its face. The femora and bent tibiæ are rubbed over the clypeus, the numerous stiff hairs on which act like a comb or brush in freeing the spines of dirt."

There is no doubt at all but that this insect passes within a few months of seventeen years of its life below the surface of the ground, and in the two stages of development. In the south and reaching at

NOTE—*Prof. H. Osborn, in Proc. Iowa Acad. Sci., 1895, page 202, quotes Mr. E. D. Ball, as stating that the common Dog-day Cicada, *C. tibicen*, is found quite abundantly in the prairie regions of Iowa, sometimes four or five to the square rod among grass, where the nearest trees were 10 miles away, and these only bush willows fringing a stream.

least as far north as northern Missouri, there are what are termed thirteen-year locusts, but which are really the same species, not differing materially excepting that they require but thirteen years for their development. As yet we have no trace of a thirteen-year brood in Ohio. The northern boundary of this thirteen-year brood is about latitude 38°, while the seventeen year brood extends southward to about latitude 35°, so that the two races sometimes occupy the same territory, overlapping each other as broods XX and XV do in north-eastern Ohio.

INJURIES CAUSED BY THE PERIODICAL CICADA.

Of course, this refers directly to the effect of oviposition by the female, in piercing the twigs of trees, or even the trunks of young trees. Plate I, Fig. 4, shows the effect of an attack of this sort on young pear trees, growing along by the side of a vineyard, which I visited near Painesville, Ohio, many of the vines of which had been badly injured, though only temporarily, by the younger growth having been badly punctured, in some cases giving the vineyard a brown appearance that could be easily seen at a considerable distance away. Although I have known them to work serious damage to raspberries and blackberries, killing the old growth before the fruit had ripened, and destroying the young shoots, these injuries would of course affect two crops and disappear in the spring of the year, and new shoots be put forth during the following season. The most serious trouble comes from the female attacking young orchards and frequently, not only riddling the limbs, but also the trunks of the small trees, and under these circumstances the injury is frequently a very serious matter.

There is no conclusive evidence that the young work any injury whatever to the roots of trees; their very slow growth precludes the possibility of their extracting any large amount of sap from the roots

NATURAL ENEMIES.

Since the advent of the white man, each brood, in all probability, reappears in constantly decreasing numbers, and owing to the denuding of the land of forests, the areas of their habitat must necessarily be constantly changing; but while man is probably one of the greatest enemies of the Cicada, it is doubtful whether he can be called the worst; unless we charge to him the work of the English sparrow, on the score of the latters artificial introduction into this country.

In 1885, in Indiana, I first saw the English sparrow come in contact with the Periodical Cicada. In the city of Lafayette the insect appeared in considerable abundance, and for a few days there was no lack of the well-known note of the male, but suddenly there was a decided falling

off, and by listening carefully one would occasionally detect a note suddenly cut short at its very height, and close watching revealed the fact that the sparrow had come to recognize the note as well as the form of the musician, and as a result, within a few days, though there were myriads in the woods, not a single Cicada could be found in the city, and the abundance of wings upon the pavements show too well the tragedies that had been enacted there.

With these observations in mind I watched for the coming of brood XV in Ohio with considerable interest. On the morning of May 28 a full complement of wings was found on the pavement under a shade tree, in Wooster, and during the following days these detached wings became more numerous, but not a Cicada note was heard. Going into the residential portion of the town at dusk, I would observe pupæ emerging from the lawns and making their way to the shade trees across the pavement bordering the street, but not one could be found the next morning, though the pavement was littered with detached wings. While back in the woods a half mile away there were great numbers of them, creating almost a continual din during the day, in town during the whole season I saw only a single living adult, and heard not a single note.

In southern Ohio, I one day watched the Cicadas attempting to make their way across a clearing, from a bit of woods to an orchard situated some distance away and below the woods, which was on a bluff. The afternoon sun shone directly across the clearing, thus enabling me to witness every attempt of the insects to fly from woods to orchard. The sparrows were in the latter, and the moment a Cicada appeared its silvery wings would glisten in the sunlight for a few moments, when a sparrow or sometimes two of them would make a dash for it, and if the prey was missed, as was sometimes the case, the bird would turn suddenly and try again, generally with better success. I watched the actions of birds and insects for a couple of hours, but did not see a single Cicada cross the clearing. Though there were numbers of *Pieris rapæ* and some other butterflies winging their way about over the clearing, I did not see a single mistake made on the part of the sparrows. They had become adept enough in two or three weeks to be able to distinguish a Cicada with an unerringness that was simply surprising, when we come to consider that none of their immediate progenitors could have seen or tasted a Cicada.

A large number of our correspondents mention the fact of the Cicada being destroyed by the English sparrow, among whom are: Prof. H. E. Chapin, of Athens; Geo. W. Gill, of Columbus; Fred'k Sillery, of Mc Connelsville, and a number of others. In fact this attack seems to have been general over the entire area. Of course the friends of the sparrow are highly elated over the victory of their favorite, but it is still questionable whether we can afford to keep the sparrow for seventeen years, for the sake of destroying an insect that occurs but once during that period.

Other bird enemies appear to be very few, and these not over-voracious. Mr. J. J. Harrison, of Painesville, Ohio, saw the crow black-bird feeding upon them in 1846, while this year the laborers on the Station Farm at Wooster claim to have observed the robin attacking them. A species of tachina fly seemed to play havoc with the latter portion of the brood, for either owing to this or some other reason, they suddenly disappeared between June 24 and June 28. On the former date, in the Experiment Station orchard, they were excessively abundant, while on the latter there was not a living Cicada to be found there, while the stench arising from the dead bodies was quite apparent to one walking through the orchard.

According to Dr. Harris, the eggs are eaten by birds; the young when they first issue from the shell are preyed upon by ants; while Dr. Riley states that the pupæ, when leaving the ground to transform, are attacked by different quadrupeds and cannibal insects, such as dragon-flies, soldier bugs and ground beetles. In my own observation, I have never seen anything of this sort; I can hardly conceive of an ant killing a great many young, or a dragon-fly carrying off very many pupæ, although I have seen a dragon-fly in Louisiana on the wing with the large swallow-tail butterfly, *Papilio troilus*, in its jaws. Of course domestic fowls are very fond of them, and no doubt hogs root out and destroy a great many of the pupæ.

The large Digger-wasp, *Sphecius speciosus*, has a peculiar habit of provisioning its nest with the Cicada. While preying principally upon our more common species, it has been observed by Mr. Rathvon, to carry off individuals of the Periodical Cicada. Of this Digger-wasp, Dr Riley has later, (Insect Life, Vol IV, pp. 248-252) given us the following interesting information

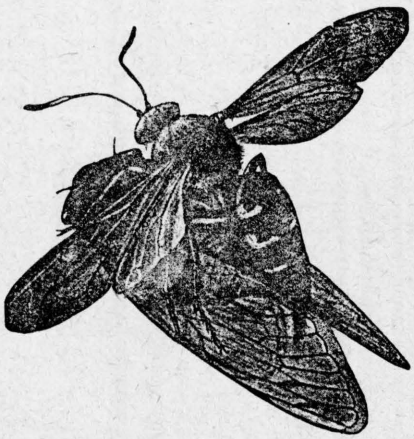


FIG. 7. Female Sphecius carrying a Cicada to her burrow, natural size. (After Riley, From Insect Life, Vol. IV. p. 248, U. S. Dep't. Agr. Div., Entomology.)

"One of the most common of our digger-wasps, as well as one of the largest and most conspicuous, is the *Sphecius speciosus*, a brown-black insect with

yellow markings on its abdomen, and commonly known as the Hornet. That it feeds in the larva state on our large Dog-day Harvest-fly or Cicada (*Cicada pruinosa*) has long been known to naturalists, but it is not known to people generally, though the curious habit of the wasp in seizing and straddling its larger victim and laboriously climbing up some tree, from which it can take a descending flight to its burrow, is frequently observed and rarely fails to elicit inquiry as to what the purpose of the act may be.

"During the latter half of July and the first of August, when the note of the Cicada in question is filling the air with its vibrations, our digger-wasp is not idle, but may be observed in rapid, strong flight about the trees harboring its prey The sudden cessation of the regular note of the unsuspecting Cicada and in its stead a distressing discordant cry will catch the ear of the observer and apprise him that something is wrong, if he be in any way acquainted with the subject of the tragedy that is being enacted. A quick thrust of the sting of the wasp into the body of its victim paralyzes the latter and throws it into a comatose condition, from which it never recovers. The vital functions are suspended or greatly reduced, but not entirely stopped, and it becomes the nonresisting, half inanimate prey of the delicate larva of the wasp. The effect produced by the sting of one of these wasps on the insects which they provide for their young has always been a subject for speculation, and a curious fact is that should the egg of the wasp fail from any cause to hatch, the paralyzed victim nevertheless remains in a state of suspended animation, which will last under favorable conditions for a year and how much longer is not known. In this preliminary struggle with the Cicada, both the wasp and its victim often fall to the ground, and the wasp must carry the latter back into the tree to get a vantage point from which to fly in the direction of her burrow. Frequently it will be necessary to carry the Cicada several times up the tree, with the expenditure of great labor, before the burrow of the wasp is reached.

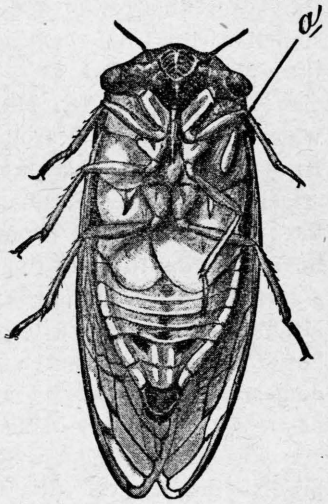


Fig. 8—Adult Cicada with Sphecius egg attached at *a*, natural size. (After Riley, From Insect Life, Vol. IV, p. 249, U. S. Dept. Agr. Div., Entomology.)

"The particular species of wasp under consideration chooses for her burrows the dryer and more elevated portions of lawns, especially the slight terraces along the sides of roadways. Experience shows that the species requires comparatively dry ground in which to undergo its transformations, excessive moisture inducing mold in the stored Cicadas, many of the specimens unearthed being destroyed by this agent. On the other hand, in dry earth I have found Cicades in excellent preservation, which had evidently been placed there a year previous, but under which the wasp egg had failed, for some reason, to hatch.

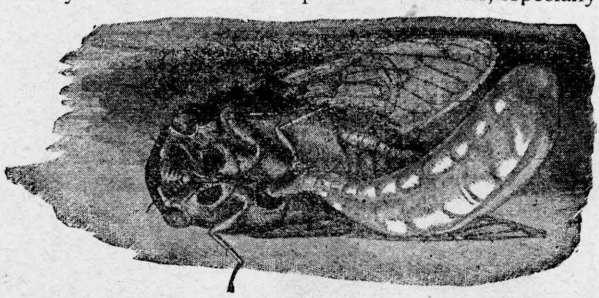


Fig 9—Cicada in burrow of Sphecius, with full-grown larva of latter feeding-natural size, (After Riley, From Insect Life, Vol. IV, p. 250, U. S. Dept.. Agr. Div., Entomology.)

"The exceedingly delicate, pure white, elongate-ovoid egg of this species is deposited in such a position as to be covered by the median thigh of the Cicada. (See Fig. 8.) In hatching, the larva does not emerge from the skin of the egg, but merely protrudes its head and begins at once to draw nourishment from between the sternal sutures of the Cicada. (See Fig. 9.) The egg requires but two or three days to hatch, and the larval life is very brief, not much exceeding a week.

"The general form of the mature larva is shown at Fig. 10 *a*. It possesses great extensile and retractile power, which enables it to thoroughly explore and exhaust the body contents of its prey. At full growth it measures from one and one-fourth to two inches in length, and is nearly white in color. The head and mouth parts (Fig. 10, *e*, *f*, *g*.) are remarkably well developed for a Hymenopterous larva. The cocoon is constructed very rapidly, not more than two days being

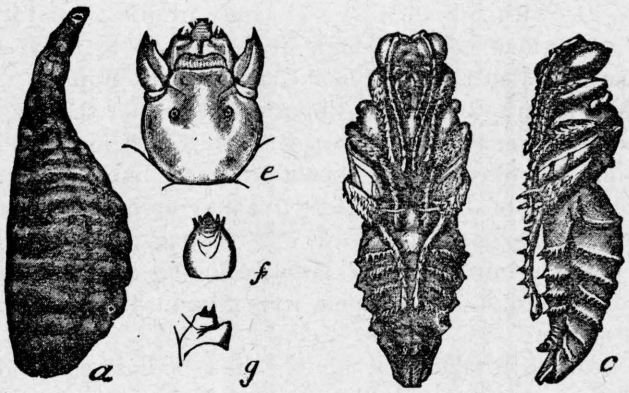


Fig. 10.—*Sphecius speciosus:* *a*, larva; *b*, p upa from below; *c*, same from side natural; *e*, head of larva; *f*, labium of same; *g*, maxilla of same—enlarged. (After Riley, From Insect Life, Vol. IV, p. 251, U. S. Dep't. Agr. Div., Entomology.)

required for this purpose. The cocoon at first consists of an open cylinder, the ends of which are ultimately closed. It is constructed of earth, with enough silk incorporated to make a rather dense body. About the middle of the cocoons are a number (about a dozen) of very curious pores (Fig. 11) and these have, so far as I know, never before been observed or described in the cocoons of any other fossorial wasps, and their use can only be surmised.

"In the completed cocoon they are capped on the inside, but during construction they must have been open and afforded a means of entrance for air, for ventilation, and respiration. They are placed in two irregular rows on one side of the cocoon and rise like minute tubercles with a truncate rim somewhat above the general surface exteriorly. They are composed of a glue-like substance and penetrate the wall of the

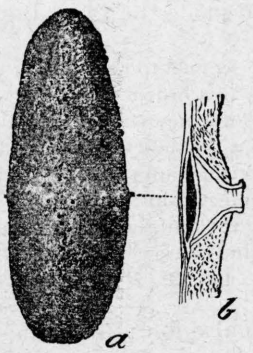


Fig. 11—*a*, cocoon of Sphecius natural size; *b*, enlarged section of pore. (After Riley. From Insect Life, Vol. IV, p. 252, U. S. Dep't. Agr. Div. Entomology.)

cocoon, broadening to the inside, where they are closed, first, by a lining of silk then by a thickened layer of the glue, and finally by silk which gives this median portion of the cocoon, inside, a paler coloring than the rest. The larva remains unchanged in this cocoon over winter, and transforms to the pupa state in the spring, shortly before the appearance of the mature insect. The pupa (Fig 10, *b*, *c*,) resembles the mature insect in general appearance, but, as in all such cases, is soft-fleshed and whitish in color. It rapidly hardens and changes to the dark color of the imago, which is ready in a few days to gnaw its way out of the pupal cell, and, in passing through the burrow made by the perfect insect the previous year, begins again the cycle of existence which its emergence has just completed."

As will be observed from the foregoing, this interesting wasp probably long ago solved the cold storage problem in a manner at least congenial to its own requirements. The only trouble is that it does not commence operations early enough in the season to fully secure the bountiful harvests that the Periodical Cicada would supply.

They also seem to be attacked by a species of fly, the eggs of which may sometimes be seen attached to their bodies, and maggots are often found within. We have, as yet, been able to rear but a single species of fly from the bodies of locusts collected about orchard trees and whose bodies contained maggots. This was a Sarcophaga, the exact species of which was not determinable by Dr. Howard and his assistants. It seems, however, to be more of a scavenger, living upon the decaying bodies, than a true parasite.

When death overtakes the adults, their bodies seem to be almost entirely empty in the case of both sexes, but sometimes the abdomen of the male is filled up, posteriorly, with a green fungus. Males have been noticed flying about with the abdomen unusually inflated, dry and brittle and totally dead, and upon breaking off the hinder part of the abdomen, the dust-like spores will fly about as from the puff-ball.

Mr. R. H. Warder, of Cincinnati, Ohio, observed this some years ago, and made the following statement to Dr. Riley:

"It seemed to be a drying up of the contents and membranes of the abdomen, generally of a brown color, and dry and brittle. I found that in many cases the male organs of generation remained so firmly attached to the female during copulation that the male could only disengage himself by breaking away, leaving one or two posterior joints attached to the female, and it is these mutilated males which I found affected by the peculiar fungus mentioned, and therefore concluded that the "dry rot" might be the result of broken membranes. I never found one thus affected in the very early part of their season, and I never found a perfect male thus affected. But this is not positive proof."

We also found this fungus in the bodies of individuals picked up on the Station premises.

I shall be obliged to confess that when I began to map out the area covered by brood XV, it was with more enthusiasm than I could command when I finished the survey. The map indicates, with a good degree of accuracy, the area over which the brood occurred in 1897, but that it

will as accurately show the area covered by the brood in 1914, I have no expectations. The continued destruction of forests and the inroads made upon the brood by its natural enemies will result in great changes, not only in the outline of the area of habitation, but this will be composed of more and more isolated and continually decreasing "Cicada Islands," as I might term them, until the well-known notes of the male will have ceased forever, and the voiceless female will have followed her ouse into the shades of oblivion.

REMEDIES AND PREVENTIVES.

Upon this head there is comparatively little to be said. Dr. Riley learned that the newly emerged adult succumbed readily to kerosene emulsion and pyrethum, but neither could be used to advantage in preventing developement, or protecting vegetation from ovipositing females. Of course they cannot be poisened.

If the young are developing in an orchard, it will be found profitable to turn hogs in during April and May, and these will probably root out and devour many of the pupæ. As against such as breed in the woods, and make their way to the orchards, little can be done.

It is a good idea to prune little if at all during the winter and spring preceding an appearance of the Cicada. In case of valuable trees the tops can be covered with mosquito netting, and the trunks covered with manila wrapping paper. It is best not to plant young orchards during the year of an occurrence of the Cicada or during the year preceding

SUMMARY.

The Periodical Cicada belongs with the true bugs, and has a sucking mouth like the chinch bug and squash bug. The eggs are deposited in the twigs of trees and shrubs and on these hatching, the young drop to the ground and burrow down to the roots.

The male only has musical organs. The young remain nearly seventeen years under ground when they make their way to the surface and climb trees and shrubs, when the skin bursts and the fully developed Cicada appears.

There are various broods or races of the Periodical Cicada appearing in various sections of the country during different years. The 13-year Cicada is not different from the 17-year Cicada, except in that it requires a shorter time for its development.

The principal injury done by the insect is by puncturing the twigs and limbs of trees and shrubs and the canes of raspberry and blackberry bushes.

There are four well marked and strong broods in Ohio during the 17-year period.

The adults are destroyed by the English sparrow and to a small extent by other birds.

Kerosene emulsion and pyrethum mixed will destroy the newly emerged adults.

Hogs root out and destroy the pupæ, and domestic fowls destroy the adults.

It is best not to prune trees, especially young orchards, the season preceding an occurrence of the Cicada, and it is also better to forego planting during the same period.